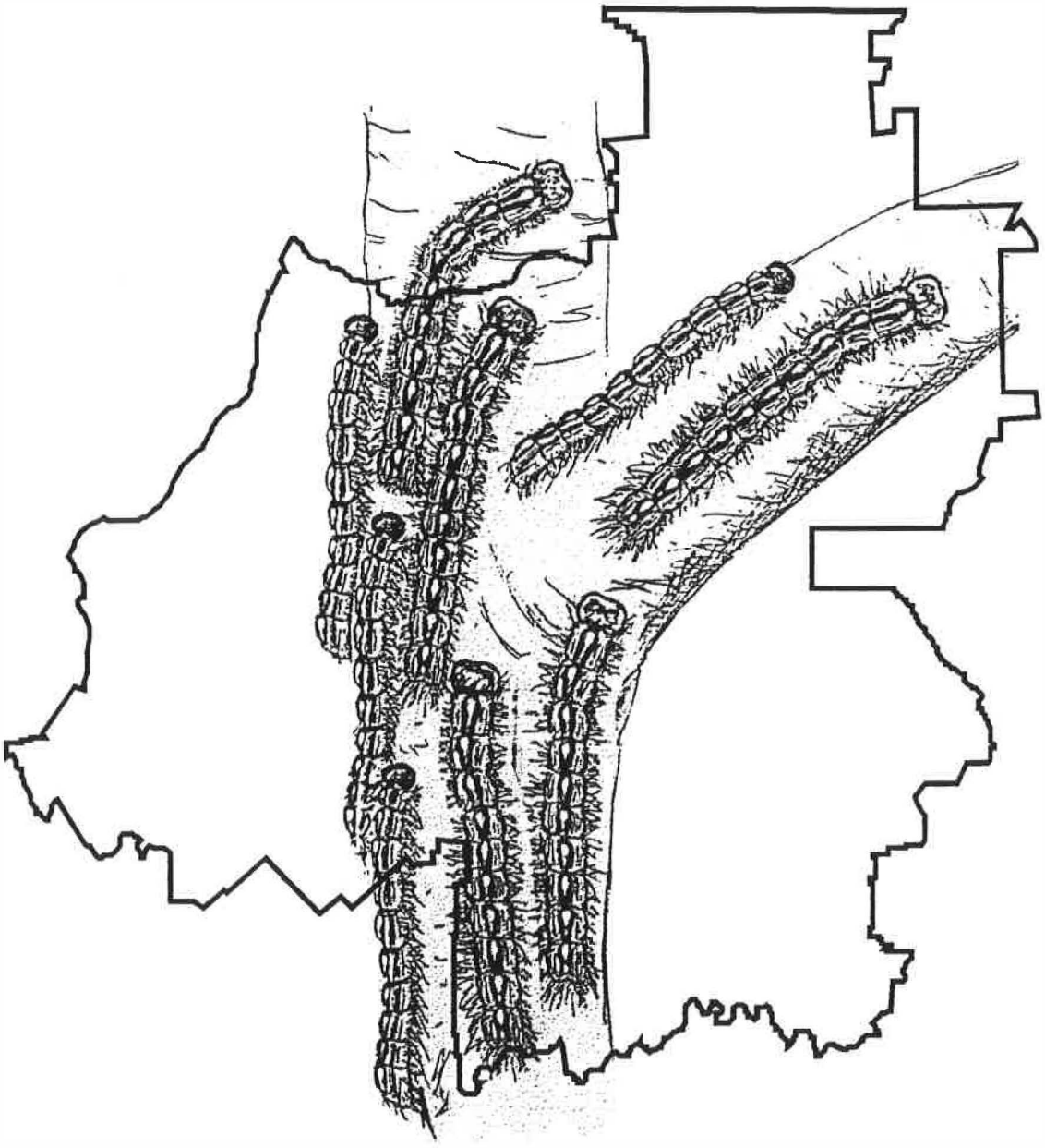
BIOLOGICAL EVALUATION
FOREST TENT CATERPILLAR POPULATIONS
ALLEGHENY NATIONAL FOREST, PENNSYLVANIA
1994



NORTHEASTERN AREA
State and Private Forestry

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FOREST SERVICE
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BIOLOGICAL EVALUATION OF FOREST TENT CATERPILLAR POPULATIONS ALLEGHENY NATIONAL FOREST, PENNSYLVANIA 1994

ABSTRACT

The forest tent caterpillar, *Malacosoma distria* (Hubner), remained a major defoliator of the northern hardwood forests over much of the Allegheny National Forest in 1994. Over the past two years forest tent caterpillar defoliated over 22,000 acres with 81 percent occurring in 1994. The forest tent caterpillar is a general feeder and will eat most broadleaved trees. Recent forest tent caterpillar surveys indicate a continuation of infestation in 1995 with moderate to severe defoliation predicted on over 58,000 acres. Natural control factors associated with fly and wasp parasitism of forest tent caterpillar cocoons and eggs, respectively, are expected to have only a minimal influence on the continuation of the current infestation.

Suppression of the forest tent caterpillar infestation on 58,000 acres through aerial application of the microbial insecticide *Bacillus thuringiensis* variety *kurstaki* (B.t.k.) is recommended for 1995. B.t.k. spraying has a high probability of reducing defoliation and its impact on forest resources. Impacts include tree mortality and timber loss, increased nuisance to recreationists from larvae presence, and reduced tree species diversity for wildlife and forest health. An assessment of B.t.k. effects on the non-target moth fauna and their wasp parasitoids in the sprayed areas is also recommended.

INTRODUCTION AND BACKGROUND

Over the past two years, forest tent caterpillar infestations have defoliated a cumulative total of 22,310 acres (4,230 acres in 1993 and 18,080 acres in 1994). Defoliation has been concentrated in mixed hardwood stands, defoliating most broadleaved trees in these stands. Species defoliated include: sugar maple, oaks, aspen, cherry, ash and basswood.

Trees subjected to continued defoliation which removes most of their foliage are stressed through depletion of stored food reserves to replenish lost leaf surface. Trees can become further stessed if drought conditions develop. Substantial tree mortality on parts of the ANF has resulted when outbreaks of another hardwood defoliator, the gypsy moth, and drought have coincided. Major salvage sales within the oak type of the Sheffield, Bradford, Ridgway and Marienville Ranger Districts have resulted. Adverse effects of forest tent caterpillar (FTC) defoliation on the northern hardwood type of these ranger districts could lead to more changes in species composition, lost revenues through salvage and disruption of scheduled management plans.

Since the occurrence of unacceptable tree mortality in the oak type from gypsy moth infestations during the 1980s, there has been concern among ANF land managers as to how they could maintain the overall tree species diversity throughout the Forest under the threat of outbreaks from additional forest defoliators. In response to this concern, Forest Health Protection (FHP) has designed a survey which emphasizes collecting information on forest tent caterpillar infestations most likely to cause the greatest risk to susceptible host types on the ANF.

OBJECTIVES

The objectives of this biological evaluation were: 1) to accurately assess current FTC overwintering egg mass densities within the northern hardwood forest type of the ANF; 2) to determine the likelihood that FTC infestations would continue in these areas in 1995; 3) to determine the most likely impacts on ANF forest resources from a continuation of the current infestation; and 4) to develop treatment alternatives and recommendations.

FOREST TENT CATERPILLAR BIOLOGY

Infestations

The FTC is found throughout North America in association with hardwoods. It feeds on most broadleaf hardwood trees, in the northeast they prefer sugar maple and aspen, but will eat oak, cherry, ash, sweetgum, basswood, willow, and cottonwood. it is a native insect which may have regional outbreaks every 6 to 16 years in the northern areas.

These outbreaks usually last two to six years. Tree mortality is usually not severe, but volume losses in reduced growth following severe defoliation is great. When combined with previous stresses such as drought and frost, tree mortality can increase substantially.

Most of the FTC defoliation on the ANF has occurred in areas which have already been defoliated at least once during the last 10 years. When added to other stresses, additional FTC defoliation can cause significant mortality in effected stands. This can have a devastating impact on the forest resources; impacting recreational activities, wildlife habitat, timber and vegetative diversity.

Life History

Eggs are laid from early June through early July in masses of 100 to 350 which encircle small twigs of the upper crown of trees. The dried eggs are hard and glossy dark brown in color. The FTC has one generation per year. Within three weeks after laying, the embryos have developed into pharate larvae. The larvae remain in the egg shells through the winter and hatch in early spring. Hatch begins about the time host trees break bud. The young larvae feed on the expanding buds, older larvae feed on the expanded foliage. The larvae usually pass through five instars as they develop. Larvae do not construct tents, but construct silken mats where they congregate when at rest or during molting periods.

When newly hatched, the caterpillars are black in color, have conspicuous hairs, and are less than one-eighth of an inch long. With each successive molt, their markings become more visible. In the last instar, each caterpillar has pale bluish lines along the sides of its brownish body and a row of foot print-shaped white spots on a black background running down its back. Five to six weeks after hatching, the caterpillars reach full size. When full grown, the caterpillars are about two inches long. They construct cocoons in sheltered areas; a folded leaf or bark crevice which are constructed of silk, colored yellow by a powdery material among the strands.

Adult moths emerge from the cocoon after about 10 days as a pupae. Adults of both sexes begin flying in June and July and live for only a few days. They are buff colored with two darker oblique lines near the middle of the forewings. They have a wingspan of one to one and a half inches. Adult moths of both sexes are attracted to lights and may be spread by the wind over large areas.

Natural Control Factors

There are many factors which can influence survival of outbreak populations: low winter or spring temperatures can cause mortality of the pharate larvae; harsh weather conditions may kill large numbers of early instars; excessively high temperatures late in the spring may kill large numbers of adults; in completely defoliated areas large numbers of larvae may starve to death. They can also be impacted by other insects. The fly, *Sarcophaga aldrichi*, parasitizes the cocoon and is very important in controlling outbreak populations. Populations are also impacted by parasitic wasps, predatory beetles, ants, true bugs, spiders, birds, and small animals. A polyhedrosis virus sometimes kills enormous numbers of larvae during the late stages of an outbreak.

SURVEY PROCEDURES

The following methodology was used to evaluate forest tent caterpillar populations on the Allegheny National Forest. It was developed by D.P. Connola, W.E. Waters and W.E. Smith (1957).

FOREST TENT CATERPILLAR (*Malacosoma disstria*) SEQUENTIAL SURVEY

Stages of Insect to be Sampled

Eggs. These are laid in masses of about 100 to 350, normally about 175, which entirely encircle twigs up to one-half inch in diameter. Each mass is cylindrical, about one-half inch long, has flat ends, and is coated with a glossy, dark-colored, glue-like substance. Embryos develop into first instar larvae within three weeks after being laid in mid to late June, but remain in the egg until the following mid or late April. The occurrence of 5 to 14 egg masses per 6-inch dbh tree is usually associated with moderate defoliation and 15 or more with heavy to complete defoliation.

Time to Sample

From July to following mid-April. The best time is in the late fall or winter as parasitized and diseased eggs can be readily distinguished at this time.

What to Sample

Aspen, poplars, sugar maple (does not feed on red maple), black cherry, and species in the red oak group. Stands to be sampled should contain at least 50 percent of these species. The insect also feeds on other trees such as birch, ash, alder, elm, gum, and basswood, but these should not be sampled unless the primary species are absent.

How to Sample

Plot size is 100 acres, or less if time and manpower permit more intensive sampling. The sampling area should be at least one acre in size. The sampling unit is five 30-inch twigs per tree. If eggs are very few in number or very numerous, the sampling may only require one or two trees. Sample trees are selected at random and should be representative of the stand. Avoid roadside trees and those so large that only the lowest limbs are reachable. Using a pole pruner, cut five twigs from various crown levels around the tree and from the outer portion of the crown. The number of eggs seen is recorded after the five twigs are cut.

The count of egg masses from the first tree will determine whether or not it is necessary to examine five twigs from another tree. This determination is made from the following table. If necessary to take another five-twig sample, the number of egg masses found on the second sample is added to the number found on the first

sample, and so on. It will be noted that if cumulative counts continue to fall into the second column, additional trees must be sampled until the total count falls into either the first or last column.

Evaluation

Predictions from this table should be accurate 90 percent of the time. Forest tent caterpillar outbreaks normally last three to five years with a sharp decline at the end. Valid predictions by egg mass surveys may be off target if the population is declining. This may become apparent if the number of old egg masses seen is much greater than the number of new ones. The end is usually brought about by the pupal parasite, *Sarcophaga aldrichi*.

If egg masses contain 100 eggs or less, such as may occur in heavily defoliated areas where larvae run out of food, two egg masses should be counted as one. The amount of overwintering embryo mortality can be determined during early April by carefully slicing the tops from three rows of eggs on opposite sides of a mass and then counting the number of healthy and the number of dead or diseased eggs. Use 50 random masses for this. This count could greatly affect plans on whether or not to control an infestation. To prevent tree mortality or decline, infestations should be controlled in the second year if two consecutive years of heavy defoliation are expected. The following table is used to evaluate the infestation.

		Cumulative Number of Egg Masses	
No. of 5-twig samples examined	No. expected to produce zero to light defoliation	Range within which the amount of defoliation expected is doubtful. Continue sampling	No. expected to produce moderate to heavy defoliation
1	--	0-2	3 or more
2	0	1-3	4 or more
3	1 or less	2-5	6 or more
4	2 or less	3-6	7 or more
5	3 or less	4-7	8 or more
6	5 or less	6-8	9 or more
7	6 or less	7-9	10 or more
8	7 or less	8-11	12 or more
9	8 or less	9-12	13 or more
10	9 or less	10-13	14 or more
11	11 or less	12-14	15 or more
12	12 or less	13-15	16 or more
13	13 or less	14-17	18 or more
14	14 or less	15-18	19 or more
15	15 or less	16-19	20 or more
16	16 or less	17-20	21 or more
17	18 or less	19-21	22 or more
18	19 or less	20-23	24 or more
19	20 or less	21-24	25 or more
20	21 or less	22-25	26 or more

Two alterations were made to the above sampling procedure:

1. If after five samples the cumulative count continued to fall into the second column, no additional samples were taken.

2. In several areas old egg masses were used with this methodology to determine degree of defoliation in 1994.

RESULTS

Table 1 summarizes data by administrative unit for the 310 sites sampled in 1994. Over 250,000 acres were sampled and approximately 58,000 acres are predicted to receive moderate to heavy defoliation in 1995 (Map 1).

Table 1.--1994 Forest Tent Caterpillar Egg Mass Survey Results,
Allegheny National Forest, PA.

Administrative Unit Ranger District	Number of Sample Sites	Acres Sampled	Acres Predicted Moderate/Heavy Defoliation
Bradford	130	108,000	35,000
Marienville	20	17,000	-0-
Ridgway	110	92,000	17,000
Sheffield	40	33,000	6,000
Total	300	250,000	58,000

TREATMENT ALTERNATIVES

NO ACTION

If the no action alternative is chosen, the potential exists for nuisance level larval populations and moderate to severe defoliation in isolated areas across the ANF. Should such defoliation occur, there is a high probability of additional tree mortality. Further, should no intervention occur to reduce forest tent caterpillar populations in 1995, it is likely that population densities will increase and possibly expand to currently uninfested areas in 1996.

USE OF MICROBIAL INSECTICIDE

Microbial insecticides can be effectively used to reduce forest tent caterpillar populations. The only biological insecticide currently registered and commercially available for control is *Bacillus thuringiensis* variety *kurstaki* (B.t.k.) at 8 to 16 billion international units per acre. B.t.k. is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is mid-gut paralysis which occurs soon after ingestion causing a cessation of feeding and death by starvation.

RECOMMENDATIONS

If additional tree mortality is a concern, FHP recommends the ANF consider the aerial suppression alternative.

Potentially damaging forest tent caterpillar populations exist within those areas of the ANF. The forest stands in the areas potentially affected by the forest tent caterpillar are managed for tree species diversity, timber, and recreation. Basically, the ANF managers have two alternatives:

1) no action
2) aerially spray in selected areas the registered microbial insecticide B.t.k. to prevent nuisance, defoliation, and subsequent possible treemortality.

If the no action alternative is chosen, the potential exists to continue the moderate to severe defoliation in numerous areas across the ANF. Resulting mortality has the potential to interfere with management by accelerating tree mortality rates in the northern hardwood forest type.

By choosing the suppression alternative, the ANF forest resource values such as recreation, timber, and tree species diversity would receive maximum protection by suppressing forest tent caterpillar.

FHP also recommends that the ANF continue to conduct non-target monitoring. Non-target moths and wasp parasitoids of the elm spanworm and other lepidoptera should be monitored at the same site the year of spraying and during the following year to assess spray effects on invertebrate biodiversity in the northern hardwood type of the ANF. Management decisions about the influence of parasitism on populations of this and other forest defoliating lepidoptera need to be improved so that suppression is both timely in anticipation of outbreaks and so that naturally collapsing outbreaks are not sprayed.

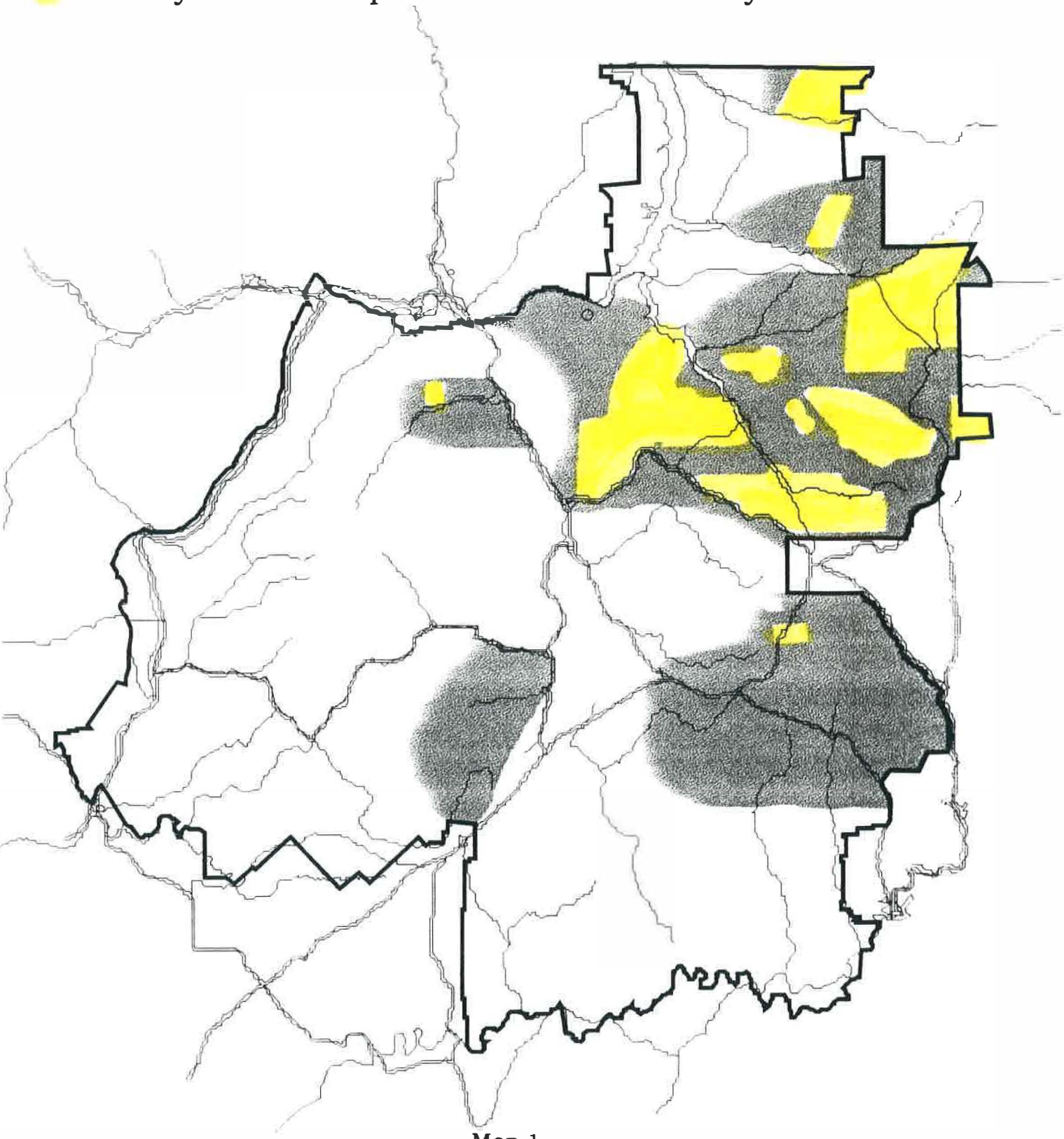
REFERENCE

Connola, D.B., W.E. Waters, and W.E. Smith. 1957. The development and application of a sequential sampling plan for forest tent caterpillar in New York. New York State Museum and Science Bulletin 366, 22pp.

Forest tent caterpillar egg mass survey and expected moderate to heavy defoliation areas.

area surveyed

surveyed area with predicted moderate to heavy defoliation



Map 1.